Key Planning Factors

For Recovery from a Chemical Warfare Agent Incident

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14. ABSTRACT

This technical report serves as an information source on key planning factors for response and recovery following a wide area release of a chemical warfare agent or other highly toxic chemical. The information contained in the technical report: (1) Provides Federal planners and leadership with key planning factors relevant to response and recovery activities following chemical incidents; and (2) Supports national efforts aimed at developing an integrated, all-of-Nation, capabilities-based approach to preparedness. Planners and exercise developers will use the information and scenarios to generate customized plans, and to compare plans based on various inputs and assumptions. The Key Planning Factors addressed in this report include: Planning, Public Health and Medical Services, Public Information and Warning, Economic Recovery, Operational Coordination, Health and Social Services, Environmental Response / Health and Safety, Housing, Restoration & Revitalization of Infrastructure Systems, Natural and Cultural Resources, Public and Private Services and Resources.

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FOREWORD:

The “The Key Planning Factors for Recovery from a Chemical Warfare Agent Incident” is a draft document developed by Sandia National Laboratories (SNL) under contract to DHS S&T as a stand-alone deliverable to the Wide Area Resiliency and Recovery Program (WARRP). This document is part of the Response and Recovery Knowledge Products (RRKP) data transition agreement established between DHS S&T and FEMA in September 2011. It is designed to identify key planning factors that could substantially aid the recovery process by decreasing the recovery timeline and costs, improving public health and safety, and addressing major resource limitations and critical decisions.

DHS S&T would like to thank the following individuals and groups for their support in development and review of this document. The content represents the best efforts of the participants based on the information available at the time of publication, but is not intended to convey formal guidance or policy of the federal government or other participating agencies. The views and opinions expressed herein do not necessarily state or reflect those of their respective organizations or the US Government.

The modeling and analysis provided by this report would not have been possible without extensive interactions with the State of Colorado and local public safety agencies in an effort lead by Gary Briese. We are also grateful for the workshop facilitation provided by Cubic and Pacific Northwest National Laboratory.

Various Federal, state and local agencies participated in workshops and provided subject matter expert technical reviews of this document, and their assistance is greatly appreciated.

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Statement

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Nomenclature

CBR	chemical, biological, or radiological
CDC	Centers for Disease Control and Prevention
ChemOTD	*Chemical Operational Technology Demonstration*
CONOPS	concepts of operation
CWA	chemical warfare agent
DHS	Department of Homeland Security
EMT	emergency medical technician
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
ERLN	Environmental Response Laboratory Network
FEMA	Federal Emergency Management Agency
HazMat	hazardous materials
HD	sulfur mustard
HL	Agent Yellow
ICS	Incident Command System
IMAAC	Inter-Agency Modeling and Atmospheric Assessment Center
L	Lewisite
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDRF	National Disaster Recovery Framework
NPDES	National Pollutant Discharge Elimination Program
NPG	National Preparedness Goal
OPCW	Organization for Prohibition of Chemical Weapons
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act

RSF	Recovery Support Functions
SME	subject matter expert
UC	Unified Command
WARRP	Wide-Area Recovery and Resiliency Program

1 Introduction

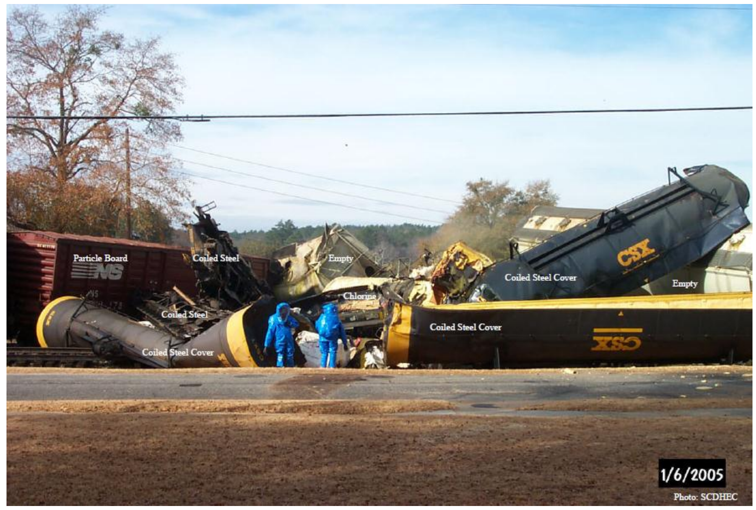

Figure 1. Site of a 2005 freight train accident in South Carolina

January 6, 2005 a freight train accident in South Carolina released 70 tons of pressurized chlorine liquid. Photo source: SCDHEA, 1/6/2005.

The United States has made significant progress in building and sustaining its national preparedness (Federal Emergency Management Agency (FEMA), 2011) against the threats and hazards that pose the greatest risk to the security of the country. However, a wide-area chemical, biological, or radiological (CBR) incident will pose serious challenges for recovery of the contaminated region. As noted in the *National Preparedness Goal* (NPG) (FEMA, 2011), recovery requires timely restoration, strengthening, and revitalization of infrastructure; implementation of long-term housing solutions; a sustainable economy; and strengthening of the health, social, cultural, historic, and environmental fabric of communities affected by the incident (FEMA, 2011). Fulfilling these requirements during a wide-area CBR incident will be challenging and complex.

As an example of the challenges in a relatively small chemical incident, on January 6, 2005, a freight train accident in South Carolina released 70 tons of pressurized chlorine liquid, a toxic industrial chemical. This incident, although small on the scale of potential CBR incidents, was one of the largest community exposures of a fast-acting, deadly inhalant in modern history, leaving 9 people dead and 71 with acute health effects. It also required a one-mile wide radius evacuation that affected 5,400 residents for up to 13 days. The rail line was shut down for 23 days (the time required to drain liquid chlorine from railcars and remove damaged rolling stock), creating severe economic consequences to the railroad (see Figure 1). The recovery from this toxic industrial chemical incident had commonalities with recovery from a chemical warfare agent incident.

This document identifies and describes selected Key Planning Factors to aid in recovery planning for wide-area chemical warfare incidents. Key Planning Factors are issues that are most important to examine prior to the occurrence of an incident. In particular, Key Planning Factors are considerations that can substantially influence the recovery process by improving public health and safety, increasing the rate of recovery, reducing recovery costs, addressing major resource limitations, or informing critical decisions. Therefore, incorporating Key Planning Factors specific

to chemicals into recovery plans will increase resiliency.

Key Planning Factors for CBR incident recovery will differ across chemical, biological, and radiological areas. For instance, remediation for any agent would depend on the method of agent distribution and the agent persistence (the length of time an agent remains a health or environmental concern), Although radioactive material decays with time, this process can take decades or even centuries for many radionuclides. Radioactive material cannot be "neutralized" or made non-radioactive through any chemical process, it must be removed or allowed to decay to safe levels. CWAs that are relatively volatile and not persistent would leave less contamination, as would biological agents that degrade rapidly in the environment. On the other hand, persistent CWAs and spore-forming biological agents (*B. anthracis*) would require more active decontamination methods that may include chemical treatments to neutralize the material of concern. Radioactive material and chemical warfare agents can be in liquid or gaseous forms and have different chemical compositions with a wide range of volatilities and viscosities. Because of these properties, some materials will penetrate into some building materials more readily than others.

This document is a companion document to three other Key Planning Factors documents. Two of these documents focus on Key Planning Factors for biological and radiological incidents, and the third describes considerations for critical infrastructure and economic impact. All four documents build upon numerous technical and policy guidance documents on consequence management, response, and recovery, including the National Disaster Recovery Framework (FEMA, 2011), National Preparedness Goals (FEMA, 2011), Presidential Policy Directive 8: National Preparedness (PPD-8), and the DRAFT Remediation Guidance for Major Airports After a Chemical Attack, (DHS 2011) (FOUO). (Note that document is not final and has not been appropriately peer-reviewed and cleared by involved agencies.)

1.1 Purpose, Objectives, and Organization

The primary purpose of the *Key Planning Factors for Recovery from Chemical Terrorism Incidents* document is to motivate and inform regional recovery planning for a wide-area CWA incident. To achieve this goal, this document identifies and describes a selected number of Key Planning Factors that could substantially improve wide-area CWA incident recovery.

The objective of this document is to provide a concise technical resource that complements existing guidance and helps recovery planners prepare for issues that may significantly limit recovery success. This document is intended to serve as a catalyst for planning to address these issues prior to a CWA incident, but does not seek to identify all the possible challenges that may arise in such an incident.

Audiences for this document include local, regional, state, and federal stakeholders within the emergency preparedness community involved in CWA response and recovery planning and in operational activities.

This document has been organized to illustrate the response and recovery processes associated with a wide-area CWA incident and identify the Key Planning Factors involved in such processes. To this end, Section 1 describes the document purpose and objectives, defines the term Key Planning Factor, and discusses limitations and assumptions. Section 2 provides a general background on the National Disaster Recovery Phases and applies those phases to a wide-area CWA incident. Section 3 offers an illustrative narrative scenario to identify and describe the activities related to recovery. Section 4 identifies and describes the Key Planning Factors for CWA incidents. Section 5 provides comparisons to other scenarios, discussing the differences between recovery from CBR incidents versus natural hazards; differences between recovery from CWA incidents versus radiological or biological incidents; and differences between the example scenario and other possible CWA scenarios. Section 6 provides planning recommendations and a conclusion.

Four appendices follow: the first describing the relationships among the National Disaster Recovery Framework Recovery Support Functions, the National Preparedness Goal Core Recovery Capabilities, and the WARRP Key Planning Factors, the second describing the wide-area response and recovery phases, the third comparing the WARRP chemical, biological, and radiological scenarios, and the fourth providing information about chemical agent toxicity.

1.2 Recovery Support Functions, Recovery Gaps, and Key Planning Factors

Recovery Support Functions

The *whole community* concept described in the National Disaster Recovery Framework (NDRF) (Federal Emergency Management Association, 2011) and the National Preparedness Goal (FEMA, 2011) recognizes that all stakeholders in a community (that is, volunteer-, faith-, and community-based organizations, the private sector, local, regional, and tribal governments, and the public) are needed to effectively recover from a catastrophic incident. To facilitate pre-disaster planning and foster coordination among state and federal agencies, nongovernmental partners, and stakeholders, the NDRF identifies functional areas of assistance, known as the Recovery Support Functions (RSFs). The RSFs are:

- Community Planning and Capacity Building
- Economic
- Health and Social Services
- Housing
- Infrastructure Systems
- Natural and Cultural Resources

Key Planning Factors

For a wide-area CBR incident, each RSF will have unique technical and operational issues that require particular focus or effort. The Key Planning Factors identified in this document are threat-specific and derived from several sources, including from a comprehensive literature review and from facilitated discussions in the Wide-Area Recovery and Resiliency Program

(WARRP) Chemical, Biological, and Radiological Workshop[1] that revealed a number of critical considerations. Another important source was the WARRP systems study sponsored by the Department of Homeland Security in 2012 (Einfeld, et al., 2012). Drawing from a broad perspective—including regional risk management, site-specific recovery, and long-term public health issues developed by more than 100 local, state, federal and private stakeholders—the WARRP study identified key performance gaps and critical considerations that limited recovery effectiveness while increasing remediation timelines and recovery costs. The relationships among the NDRF Recovery Support Functions, the NPG Core Recovery Capabilities, and the Key Planning Factors are shown in Appendix 1.

The Key Planning Factors discussed here meet several criteria. They are all pre-incident planning activities, can be initiated by state and local governments, and have the potential to substantially influence the recovery process by a number of means: increasing the rate of recovery, reducing recovery costs, improving public health and safety, addressing major resource limitations, or informing critical decisions. The document focuses on Key Planning Factors for the recovery phase, rather than the response phase; however some response-phase Key Planning Factors are included because the actions addressed have the potential to have a large impact on the recovery phase. The Key Planning Factors presented here do not encompass the totality of the planning process or all of the issues that need to be addressed. Instead, this document clarifies some of the issues that will benefit most from pre-disaster community planning.

1.3 Limitations and Assumptions

This document does not describe how to prepare a plan for CBR response and recovery or provide a playbook on how to respond during a CBR incident.[2] Rather it identifies examples of Key Planning Factors that, if addressed, will provide significant value when preparing such a plan or playbook. In addition, it provides references to key resource documents that will enable readers to further research a particular subject matter. However, there are limitations in the current knowledge and understanding in this area. Thus, the reader may want to consult the most recent information provided by the US EPA and other local, state, tribal, and federal agencies before embarking on a planning effort in this area. In addition, this document only seeks to provide examples of Key Planning Factors. The examples in this document should not be considered a comprehensive list.

To provide context and increase understanding of the Key Planning Factors, this document presents a chemical warfare agent scenario featuring Agent Yellow, a blister agent. Agent Yellow is a mixture of

[1] The first workshop conducted under the WARRP Knowledge Enhancement Working Group, was held in Denver, Colorado, on January 30-31 of 2012. Forty state, local, and federal agencies collaborated in the identification of critical CBR considerations to support development of a UASI-level response and recovery framework.

[2] Planning guidance may be found in the All-Hazards Plan and CBR Annexes (REF).

persistent chemicals with low volatility, low water solubility, and strong sorption into certain materials. As a result, remediating urban areas contaminated with Agent Yellow will be challenging. The Key Planning Factors identified within this document address many of these challenges. The document also discusses instances when use of a different CWA would impact the Key Planning Factors. For example, pre-planning to rapidly identify an agent and initiate appropriate public health responses may become more important in the presence of an extremely toxic but less persistent agent, such as sarin.

A further limitation is that the document is intended to address Chemical Warfare Agents and not Toxic Industrial Chemicals. Many of the recommendations may apply to both types of agents, but to keep the document to a manageable size, Toxic Industrial Chemicals were excluded from explicit consideration.

2 Response and Recovery Phases

The National Disaster Recovery Framework phases provide a useful tool for organizing the major activities associated with wide-area CBR consequence management. This framework identifies three primary phases of action following a disaster incident—short-, intermediate-, and long-term—that can overlap, sometimes considerably. As shown in Figure 2, actions intended to address long-term recovery can actually begin during the short-term phase.

For a wide-area CWA incident, this timeframe could be compressed into a matter of hours or could last days or weeks. For example, on March 20, 1995, attackers released the nerve agent sarin through several crude devices placed in railcars in Tokyo subway stations. This attack resulted in 12 deaths, 54 individuals with critical effects, and 984 individuals with moderate effects of the agent. In addition, more than 4,000 people were examined by medical staff and released. As catastrophic as this attack was, the entire timeline, from release of sarin in the railcars to resumption of full service of the Tokyo rail system, was only 21 hours. The high volatility (16,091 mg/m^3, as opposed to mustard, which has a volatility of 610 mg/m^3) and low persistency of sarin may have contributed to this compressed timeframe, but documentation is limited on the incident clean-up and verification process. Other warfare agent scenarios, such as the Agent Yellow scenario described within, will result in longer timelines due to the agent persistence.

The Department of Homeland Security's (DHS's) Wide-Area Recovery and Resiliency Program defines the response and recovery activities as follows:

- Notification
- First Response
- Characterization
- Decontamination
- Clearance
- Restoration and Reoccupation

This list of activities was developed with input from interagency working groups from agencies such as the Environmental Protection Agency (EPA), Centers for Disease Control (CDC), DHS and others. These activities and the relationship to the National Disaster Recovery Phases are

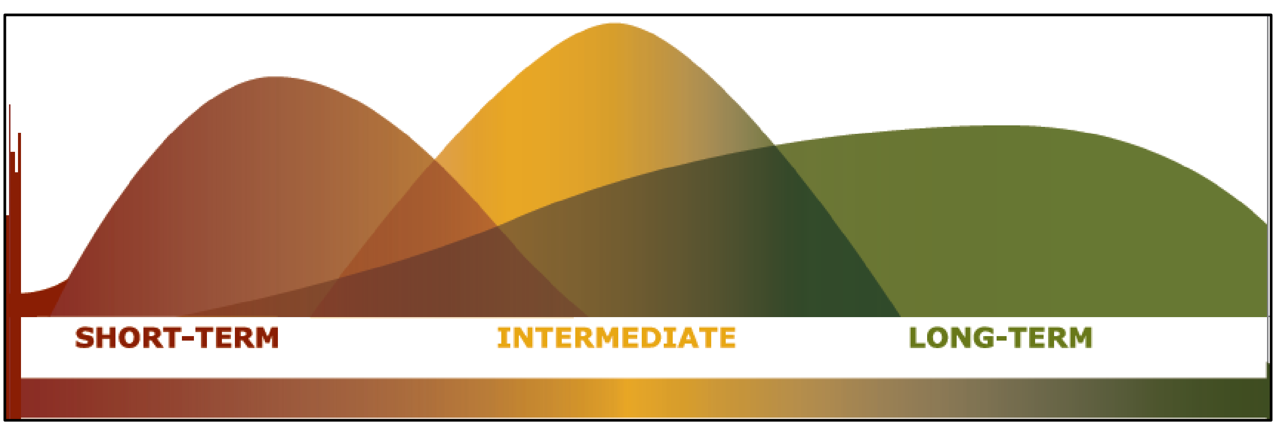

Figure 2. Overlap in the short-, intermediate, and long-term phases of incident recovery (NDRF)

discussed in Appendix 2 and are used to describe the response to the example scenario presented in the next section.

3 Chemical Warfare Agent Threat Scenario

To introduce Key Planning Factors for recovery, an illustrative CWA release scenario explores what may occur after an aerosol dispersal of a chemical warfare agent. This scenario focuses on the dispersal of Agent Yellow (HL) in downtown Denver, Colorado. Agent Yellow is a mixture of the blistering agents Lewisite (L) and Sulfur Mustard (HD) that produces the types of blisters shown in Figure 3. Although the scenario is very specific, its associated Key Planning Factors are expected to apply to releases of other types of CWA releases in other urban areas. However, certain Key Planning Factors may become more or less important, depending on the physical and chemical properties of the agent used. The sections below describe the scenario and the recovery, organized in accordance with the NDRF phases (short-, intermediate-, and long-term) and the WARRP response and recovery activities (notification, first response, characterization, decontamination, clearance, and restoration and reoccupation). The Key Planning Factors will be introduced through the discussion of response activities to this scenario.

3.1 Scenario Overview

On July 4, an unspecified number of terrorists convene in a remote air field west of Denver, Colorado. They equip a small agricultural aircraft with the CWA Agent Yellow. Shortly thereafter, the plane takes flight and sets course towards Denver's Coors Field baseball stadium, where a game between the Colorado Rockies and the San Francisco Giants is about to begin.

Figure 3. Skin affected by mustard gas

Source: http://trcs.wikispaces.com/mustard%20gas(4))

While flying in an eastward direction on a half-mile path just to the north of Coors Field, the pilot reduces speed and releases the CWA payload. A significant fraction of the agent plume travels directly into the open air stadium. The remaining fraction is carried by the wind into the surrounding area and infrastructure of downtown Denver. The plume travels a distance of over five miles. Figure 4 shows the CWA deposition map.

More than 50,000 people come into direct contact with, or breathe vapors or droplets of, the Agent Yellow spray and begin showing an array of symptoms: difficulty breathing, eye irritation, loss of coordination, nausea, or a burning sensation in the nose, throat, and lungs (see Appendix 4 for information on CWA toxicity). The presence of many dead insects or birds indicates a toxic material release and likely a chemical warfare agent.

Thousands attempt to flee the stadium, and many are injured in the rush to escape the CWA plume. Elsewhere, persons run into nearby buildings and numerous auto accidents occur on the roadways

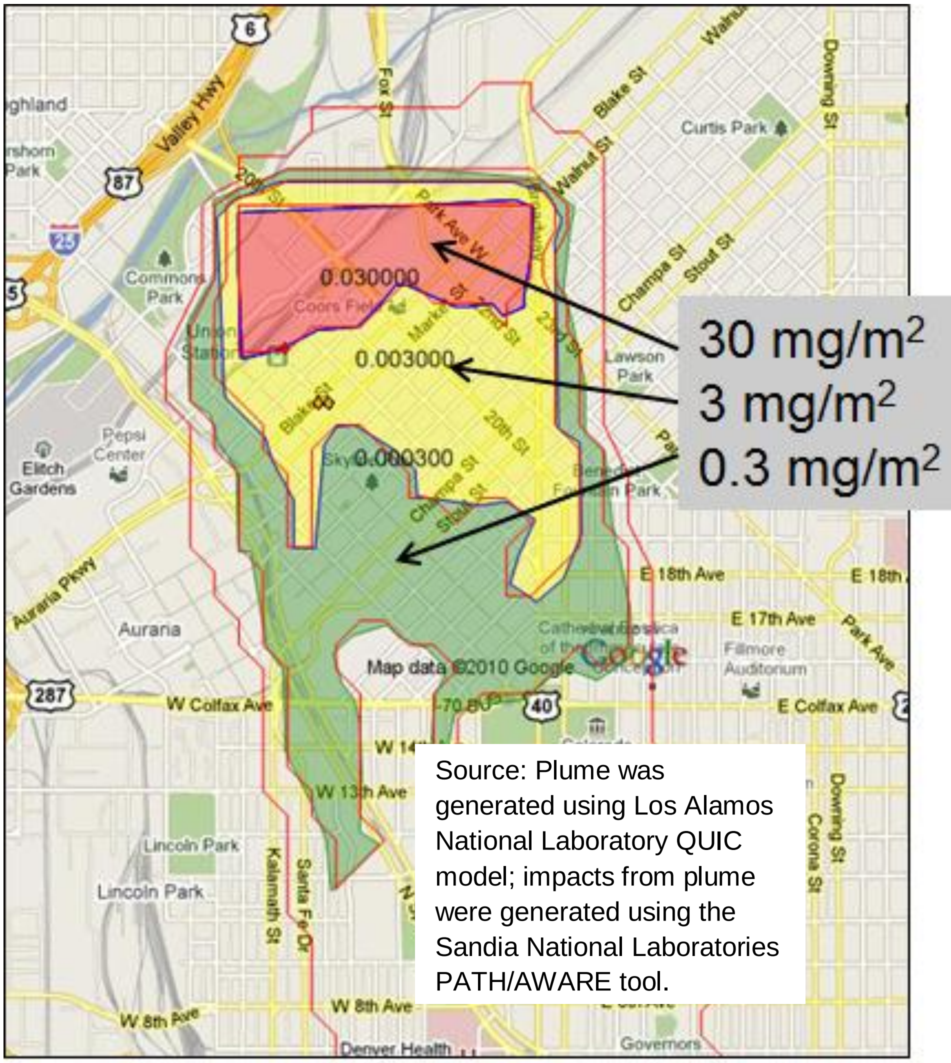

Figure 4. Deposition map for illustrative chemical warfare agent scenario

surrounding the stadium. 911 receives hundreds of calls from individuals experiencing burning sensations and blistering of the skin. Hospital and medical staff are caught unaware as victims of the terrorist attack arrive requesting immediate attention.

Characteristics of Chemical Warfare Agents

Chemical warfare agents are often categorized as persistent or non-persistent, which describes how long the chemical remains toxic and if it remains in a location to cause potential harm. A persistent CWA can remain in a liquid state and present a hazard for 24 hours or more; a non-persistent CWA will likely volatilize or degrade from a liquid state in minutes to hours, quickly losing toxicity (USACHPPM 2008a, Watson et al., 2011) (Table 1). For example, due to its volatility, gasoline will evaporate more quickly than oil under the same environmental conditions. Factors that influence volatilization or degradation rates include the ambient temperature, the wind speed, and the surface upon which the agent settles. Agent Yellow is relatively persistent; at 50°F, the evaporation time of mustard is about 100 hours on sandy surfaces and about

Table 1. Persistence of some chemical warfare agents

	Nerve Agents		Blister Agents (injure skin, eyes, and airways)		Blood Agents[†] (cause blood changes and heart problems)		Choking Agents[†]	
Examples	Sarin	VX	Mustard	Lewisite	Hydrogen Cyanide	Cyanogen Cyanide	Chlorine	Phosgene
Persistence*	Non-persistent (min to hrs)	Persistent (> 12 hrs)	Persistent		Non-persistent		Non-persistent; vapors may hang in low areas	

From http://www.dhs.gov/files/publications/gc_1243884402361.shtm#table1
*The length of time a chemical warfare agent remains at toxic levels
[†]Used both as chemical weapons and as industrial chemicals

12 hours on non-porous surfaces; Lewisite is considered to be moderately persistent in soils although there are few, if any, studies to support this (The Sources, Fate, and Toxicity of Chemical Warfare Agent Degradation Products, Munro, NB, Talmage, SS, Griffin, GD, Waters, LC, Watson, AP, King, JF, Environmental Health Perspectives, Vol 107, Issue 12, p933, December 1999). However, since Lewisite does contain arsenic, which is a persistent, elemental poison, it will almost certainly require long-term clean-up actions.

As noted above, Agent Yellow comprises Lewisite and Mustard, typically in a ratio of 63% L to 37% HD. Lewisite and Mustard are persistent agents with low volatility, low water solubility, and strong sorption into certain types of materials. Both cause severe blistering of skin and other tissue, with Lewisite causing immediate effects and Mustard causing delayed effects (Figure 5). Eye exposure can lead to temporary blindness, and severe damage to the eye may be present for a long time after the exposure. Agent Yellow can also damage the immune system and increase the risk of cancer. Likely future health effects from high levels of exposure include kidney and liver damage, as well as chronic respiratory diseases.

Figure 5. Soldiers in World War I exposed to Sulfur Mustard
Photo source: http://en.wikipedia.org/wiki/Chemical_warfare

3.2 CWA Threat Scenario Short-Term Response and Recovery

Notification Phase

As news of the terrorist attack rapidly spreads, hazardous material (HazMat) units are deployed to the stadium and downtown area to conduct chemical tests to identify the hazard agent. Simultaneously, Emergency Operations Centers (EOCs) are activated across local, state, and federal jurisdictions. The Colorado National Guard is activated.

A Unified Command (UC) is established to direct response and recovery operations, including forensic analysis and public health risk mitigation. Due to concerns of a second attack in Denver or elsewhere in the nation, aircraft across the nation are grounded and all security organizations and personnel put on high-alert. Information gathering and dissemination to all relevant agencies are the main tasks.

First-Response Phase

Local emergency medical services and first response teams are activated and arrive on scene at the stadium. Operations to rescue and treat individuals still inside the stadium begin immediately, though the cumbersome personal protection equipment (PPE) required for the unknown HazMat threat slows down operations. Personnel decontamination capabilities are stood up and staged near the Denver stadium. However, these resources are limited, and the demand greatly exceeds the supply.

Despite significant uncertainty regarding the exact area of contamination, downtown Denver is closed over an area of about 2 square miles:

- From the City of Cuernavaca Park on the north to West 8th Avenue on the south
- From I-25 on the west to Lawson and Benedict Fountain Parks on the east

There is disagreement among decision-makers and the public over whether inhabitants inside the closed area should remain sheltered-in-place or evacuate. At issue are the differences in exposure caused by each option and whether additional movement would spread the contamination further.

Based on symptoms and effects of victims, local first response teams determine that the substance is likely a chemical warfare agent but do not identify the exact agent. The National Guard Civil Support Team is called in and identifies the CWA as Agent Yellow, a persistent blister agent. Communications are dispatched to inform members of the UC and the public of the agent identification and its characteristics.

Key Planning Factor: Establish protocols for control of agent fate and transport after the initial incident

Established protocols to control the transport of a persistent agent can help prevent additional exposures and limit further spread of the agent.

Key Planning Factor: Establish protocols for first responders to rapidly identify the chemical warfare agent and determine its volatility and persistence

Agent identification typically precedes initiation of public health response measures; control of agent transport requires information about volatility and persistence.

Due to concerns of contamination outside of the area of closure, critical assets in the area of suspected contamination are closed, including the Denver Mint, Coors Field, Pepsi Center, the Metropolitan State College of Denver, and Mile High Field.

In parallel, members of the population continue to flood nearby hospitals, requesting immediate assistance. More than 60 primary care clinics, including the Aurora Urgent Care facility, Saint Joseph Hospital, and Plasma Holdings LLC Blood Bank, are potentially contaminated from either victims spreading the agent or the plume itself. Some medical workers, including ambulance drivers and EMS personnel, become ill from exposure to the agent as it off-gases from contaminated victims. Many other members of the population become exposed through secondary contamination.

Public fears over unidentified areas of contamination remain high, and security continues to be provided by the Denver Police and Colorado National Guard. In addition, there is concern about the long-term effects of exposure.

3.3 CWA Threat Scenario Intermediate-Term Recovery

The Unified Command has established multiple working groups, including a public health working group and a recovery stakeholders working group, to support recovery operations and planning. Selection of participants (e.g., subject matter experts and organizational representatives) for these groups was contentious, and several organizations are already declaring the recommendations of these working groups biased and tainted.

Risk-assessment

Many areas of contamination have been identified and cordoned off. However, new isolated "hot spots" continue to be found regularly. Outside of the cordoned zone, areas are characterized through a slow and cumbersome process, and people are gradually being allowed back to residences in areas confirmed not to be a health risk. However, more than 5,000 people remain in temporary shelters.

Risk assessments are ongoing and the Public Health working group continues to develop thresholds based on the limited data that is

Key Planning Factor: Identify and create Stakeholder Working Groups

Pre-identifying participants by position and/or skill set/expertise streamlines and adds transparency to the process, and aids in gaining buy-in from the public.

Key Planning Factor: Develop protocols to determine the extent of contamination

Established protocols can help streamline the identification of contaminated zones, knowledge that is crucial to both public health response and recovery.

available. Furthermore, the risk of contamination spreading through people and goods is considered significant and national-level warnings are issued for all goods and people that have traveled through the area or contacted people or goods from the area. Information to the public from official sources is sporadic and changing due to the evolving information on risk and on the lack of a clear communication plan. Independent "experts" also continue to inform the public through social and network media. These assessments often lack credibility, are conflicting, and contribute to public unrest.

Planning

Planning efforts are underway to identify and acquire resources from neighboring jurisdictions to support remediation operations. Those resources that are available are in short supply, and many residential and commercial facilities remain closed, awaiting screening for contamination, decontamination verification, or clearance. In addition, businesses outside the area that normally do business with the affected region remain closed due to lack of demand or concerns for public health.

Resources to conduct characterization, decontamination, and clearance activities are insufficient to meet the region's needs, and the competition for these resources is increasing within the public and private sectors.

Decision-makers are coming under intense scrutiny for nearly every decision about prioritization and resource allocation. (Note that advance planning for prioritization and resource allocation decisions is discussed in more detail in the companion document, *Recovery from Chemical, Biological, and Radiological Incidents: Critical Infrastructure and Economic Impact Considerations*.)

Key Planning Factor: Develop CWA-specific public messaging and communication strategies prior to an incident

Predefined strategies can aid timely and accurate communication and build public confidence in recovery efforts.

Key Planning Factor: Determine requirements for, and sources of, the resources for recovery from a CWA incident

Pre-identified and pre-arranged agreements with neighboring jurisdictions can facilitate this process and speed the acquisition of the resources required for recovery.

Key Planning Factor: Develop a pre-incident, wide-area CBR waste management plan

Pre-established plan can be tailored to specific incidents.

Waste management continues to be a significant challenge. At the operational level, controls on staging areas for containment, segregation, and decontamination are being developed. However, it is unlikely that waste disposal sites will be identified in the foreseeable future. In the meantime, the region is facing increased numbers of illicit or roadside dumping incidents. Plans to manage this activity need to be developed.

Furthermore, concerns are growing over the cost of remediation operations and the economic impact of the loss of business and conventions. Chokepoints in the remediation process are limiting progress, and many stakeholders in the public and private sector are asking how long remediation operations will take. At this time, no definitive answer has been given.

Characterization

Characterization of the potentially contaminated environment to determine remediation requirements relies on sampling technology that is laborious and slow. Existing field technologies may lack the appropriate level of sensitivity to support wide-area characterization of the CWA incident in an urban environment. Additionally, the safety for those conducting characterization activities is a concern.

Decontamination

Characterization of the contaminated area shows that decontamination of hundreds of facilities and areas is required. These areas include both public and private spaces and comprise commercial, residential, and industrial infrastructure. Decontamination of the Agent Yellow is challenging due to the persistent nature of the blister agent and its byproducts. Because different surfaces require different decontaminants, multiple decontamination technologies will likely be required. The fact that some surfaces will be nearly impossible to decontaminate will lead to complex decisions on decontamination versus removal and disposal.

Decontamination is being accomplished primarily through hydrolysis or oxidation, using bleach, caustic (sodium hydroxide), or hydrogen peroxide-based solutions. Over time, the degradation products from Lewisite will be transformed into both organic and inorganic forms of arsenic, themselves toxic byproducts. In addition, decontamination on porous and/or permeable surfaces may be difficult due to the decontaminant's inability to reach the agent. The amount of waste generated by various decontamination processes is also a concern. Some subject matter experts state that handling waste generated by decontamination processes is more problematic than the actual decontamination process itself. Efforts to assess the amount

Key Planning Factor: Establish a decision-making process to select among environmental remediation options

Advance planning can facilitate the time-consuming and complex process of recovery decision-making.

of waste generated by various decontamination processes are underway.

Economic impacts during decontamination might include disruption to lives and livelihoods. An attack on a food or agricultural crop could result in long-lasting economic impact for suppliers and their communities, as well as consumers.

Clearance

Re-use and re-occupancy decisions for both indoor and outdoor areas depend on health-risk-dependent clearance processes and goals. These goals drive recovery costs and timelines and represent a difficult trade-off between health risk concerns and regional economic recovery concerns: the more stringent the clearance goals, the more extensive the decontamination process and clearance sampling, the longer the cost and timeline.

3.4 CWA Threat Scenario Long-Term Recovery

The majority of the contaminated area has been reopened, though a few isolated areas of contamination (individual buildings) remain. Most citizens have been able to return to their homes, and temporary shelters are being shut down. On the commercial side, the majority of business facilities have been cleared for use and reopened to the public. A few buildings were razed and several new construction projects are underway. The Colorado Convention Center has been cleared for use, but many events have already been cancelled and as a result, tourism is expected to be at a standstill for the rest of the year. The cost of remediation operations and the economic impact associated with the loss of business and conventions are substantial.

An economic recovery working group has been established. Members of the recovery working group seek to identify and provide government incentives to businesses and individuals willing to re-occupy areas or facilities to entice people back into the remediated buildings.

Restoration and Reoccupancy

The current focus of long-term recovery efforts is revitalizing, rebuilding, or relocating affected areas and populations. Building owners have indicated that their limit for absorbing losses is only six months—meaning that if after six months, they are not earning rent and are facing large decontamination costs, they are likely to abandon their facilities. It is clear that businesses will need incentives to stay and reopen in the area. Early community engagement in a prioritization process for cleanup and clearance is vital in order to

Key Planning Factor: Establish a process to develop clearance goals specific to CWA-incident remediation

Clearance goals drive the recovery costs and timelines.

support and increase the capability to agree and move forward.

Long-term medical and environmental monitoring plans are being developed. Most health effects from a chemical warfare attack occur quickly. Some injuries from acute exposure to CWAs, such as eye damage and chemical burns, could persist for a lifetime. Detailed information on the possibility of developing other types of health effects later in life would be made available once a specific exposure is known. Additionally, long-term public information and communication programs will aid in establishing public trust.

This example scenario has raised and illustrated the Key Planning Factors for recovery from a chemical warfare agent. The next section will examine these factors in greater detail.

4 Key Planning Factors

The Key Planning Factors, introduced and illustrated in the previous section through the example scenario, have the potential to substantially influence the recovery process by increasing the rate of recovery, reducing recovery costs, improving public health and safety, and addressing major resource limitations or critical decisions. Key Planning Factors are issues that are most important to examine prior to the occurrence of an incident. This document identified ten Key Planning Factors for the CWA scenario, grouped into several areas: operational guidelines, waste management, recovery planning, clearance, and CBR and All-Hazards. These factors are shown in Table 3. Detailed descriptions, significance, and references for each Key Planning Factor follow.

Table 3. Ten Key Planning Factors for recovery from a CWA incident, grouped by category

Category	Key Planning Factor
Operational Guidelines	• Establish protocols for first responders to rapidly identify the CWA and determine its volatility and persistence • Establish protocols for control of agent fate and transport after initial incident • Develop protocols to determine the extent of contamination • Develop CWA-specific public messaging and communication strategies prior to an incident
Waste Management	• Develop a pre-incident, wide-area CBR waste management plan
Recovery Planning	• Establish a decision-making process to select among environmental remediation options • Determine requirements for, and sources of, resources for recovery from a CWA incident
Clearance	• Establish a process to develop clearance goals specific to CWA-incident remediation
CBR and All-Hazards	• Identify and create stakeholder working groups

4.1 Key Planning Factors: Operational Guidelines

Key Planning Factor: Establish protocols for first responders to rapidly identify the chemical warfare agent and determine its volatility and persistence

CWA identification typically precedes initiation of public health response measures; control of agent transport requires information about volatility and persistence.

Description

This Key Planning Factor is focused on the rapid identification of the CWA used in the terrorist attack and acquisition of knowledge of that agent's volatility and persistence.

Significance

CWA identification will enhance response operations by enabling responders to more effectively implement public health measures for worker safety (such as appropriate PPE), implement controls to limit secondary transport of agent, and apply medical countermeasures. Furthermore, identification of the agent and understanding of its volatility and persistence will help guide estimates of dispersal, sampling and analysis strategies, and decontamination techniques.[3]

In the 1995 Tokyo attack, two of the seven fatalities were station employees who attempted to clean up the liquid sarin from the floor of the subway cars. These employees did not receive adequate information about the identity and hazard of the CWA.

Resources

The DHS document, DRAFT *Remediation Guidance for Major Airports After a Chemical Attack*, (DHS 2011) (FOUO) (FOUO), provides additional information. (Note that document is not final and has not been appropriately peer-reviewed and cleared by involved agencies.) Note that results obtained through field methods should be confirmed by an Environmental Response Laboratory Network (ERLN) facility (for environmental samples).

[3] DHS, DRAFT *Remediation Guidance for Major Airports After a Chemical Attack* , LLNL-TR-408173-DRAFT, (2010), p. 6. (Note that document is not final and has not been appropriately peer-reviewed and cleared by involved agencies.)

Key Planning Factor: Establish protocols for control of agent fate and transport after initial incident

Established protocols to control the transport of a persistent agent can help prevent additional exposures and limit further spread of the agent.

Description

This Key Planning Factor includes limiting the spread of contamination after the initial release. The utility of the several mechanisms for limiting agent spread is highly agent-dependent.

Significance

Arguably, the single most important means of reducing wide-area recovery requirements is to limit the extent of contamination within and throughout the area. Minimizing the spread of contamination will reduce remediation time and cost. After the initial release and deposition, CWA may continue to spread throughout the environment via fomite transport, reaerosolization, or volatilization. Such spreading will increase the number of people who contact the agent and thus experience incapacitating health effects. Additionally, critical infrastructure, such as hospitals and medical facilities, are

likely to become contaminated. Such contamination will impact response operations and reduce the availability of key lifeline services to the region even after the response as facilities undergo decontamination.

Implementing controls and processes to limit agents spreading can reduce the extent of the contamination and thus its impact on the region's critical infrastructure and population. Further, these controls and processes will significantly reduce the risk of re-contamination of areas that have been decontaminated. Such processes may include decontamination of patients prior to their entry into medical vehicles or facilities, and decontamination of first responders and first responder vehicles.

In addition, rapid identification and securement of areas of contamination can reduce the spread of agent, as discussed in the "Determine extent of contamination" Key Planning Factor.

Resources

The following papers discuss persistence or the fate and transport of chemical warfare agents:

Love, A. H., A. L. Vance, J. G. Reynolds, and M. L. Davisson (2004), "Investigating the Affinities and Persistence of VX Nerve Agent in Environmental Matrices," *Chemosphere* **57**, 1257–1264.

Munro, N. B., S. S. Talmage, S. G. D. Griffin, L. C. Waters, A. P. Watson, J. F. King, and V. Hauschild (1999), "The Sources, Fate, and Toxicity of Chemical Warfare Agent Degradation Products, *Environ. Health Perspect*. **107**, 933–974.

Talmage, S. S., N. B. Munro, A. P. Watson, J. F. King, and V. Hauschild (2007a), "The Fate of Chemical Warfare Agents in the Environment," Chapter 4, pp. 89–125 in T. C. Marrs, R. L. Maynard, and F. R. Sidell (Eds.), *Chemical Warfare Agents: Toxicology and Treatment, 2nd Ed.* John Wiley & Sons Ltd., Chichester, West Sussex, England.

Talmage, S. S., A. P. Watson, V. Hauschild, N. B. Munro, and J. F. King (2007b), "Chemical Warfare Agent Degradation and Decontamination, *Current Org. Chem.* **11**, 285–298.

Key Planning Factor: Develop protocols to determine the extent of contamination

Established protocols can help streamline the identification of contaminated zones, the knowledge of which is crucial to both public health response and recovery.

Description

Determining the extent of contamination includes identifying contaminated versus non-contaminated areas and determining levels of agent concentration throughout the contaminated areas. Although these zones were initially established in the incident response, they must be confirmed and updated for the remediation.

Significance

Establishing and providing training on standardized methods for using field measurements, exposure data, and computer-generated contamination plume maps will help set contamination zones and determine action levels.

Field measurements must follow a sampling plan that considers agent specificity, field equipment sensitivity, and exposure standards. These characteristics are interrelated. For example, more sensitive sampling methods are required for agents with lower acceptable exposure standards.

Exposure data provides additional temporal and spatial information.

The Inter-Agency Modeling and Atmospheric Assessment Center (IMAAC) can provide computer-generated contamination plume maps, given relevant information, such as outdoor temperature, humidity, and wind speed and direction.

Resources

The DHS document, DRAFT *Remediation Guidance for Major Airports After a Chemical Attack* (DHS 2011) (FOUO), contains several relevant pieces of information. (Note that document is not final and has not been appropriately peer-reviewed and cleared by involved agencies.) The Guidance lists other sources of information that can be useful in determining extent of contamination, including video surveillance camera records, locations of victims, and information on movement of people and equipment through the contaminated areas.

Additionally, the Guidance identifies pathways that may allow the spread of contamination from an indoor release to the outdoors. These pathways include HVAC exhausts, open doors and windows, and storm drains and sewers, as well as by transport on people and vehicles.

Finally, the document defines four classes of contamination zones, as shown in Table 4.

Table 4. Four classes of contamination zones

Class 1 Zone	Known or assumed to be contaminated above clearance goals (the release location and its immediate vicinity).
Class 2 Zone	High likelihood of being contaminated above clearance goals (contamination seems likely due to proximity to release or known dispersion mechanisms, but definitive evidence of contamination does not yet exist).
Class 3 Zone	Low likelihood of being contaminated above clearance goals (contamination is possible, but seems unlikely because of distance from release point, building layout and structure, or absence of known dispersion mechanisms).
Class 4 Zone	Extremely low likelihood of being contaminated above clearance goals.

Key Planning Factor: Develop CWA-specific public messaging and communication strategies prior to an incident

Predefined strategies can aid timely and accurate communication and build public confidence in recovery efforts.

Description

This Key Planning Factor entails the development of CWA-specific messages for the affected population and the community at large, as well as the development of communication strategies between the multiple response and recovery agencies.

Significance

In any disaster response effort, establishing communication mechanisms is vital to the success of response operations. In a CWA incident, this significance is heightened due to the potential for the population to become exposed to the agent after the initial release by traveling through contaminated areas. Effective communications between the government and the public can minimize panic, enhance evacuations or other response measures, and ultimately reduce the number of casualties. Advance planning can facilitate timely, consistent messaging throughout the recovery process, building public trust in the process and thereby enhancing recovery.

After recovery, a public affairs campaign can provide consistent, valuable information regarding the areas of contamination, health risks, remediation timelines, and costs. In addition, the plan should anticipate ways to meet the media demand for information. If none is provided by official sources, the media will go to alternative sources that are likely to be uncoordinated, inconsistent, and less credible.

Due to the rapid nature of CWA incidents, communicating quickly about agent identity, health risks, and locations of contamination is critical. In the Tokyo Subway attack, the identity of the CWA (sarin) was not shared with responding agencies for a full hour after identification was made, and some hospitals were never officially notified.[3] This resulted in numerous medical personnel being exposed to the agent.

Advance planning can facilitate timely, consistent messaging across all levels of government, the civilian sector, and the private sector throughout the recovery process, but especially during early stages when public trust is likely to be tenuous. The FEMA's Incident Command System (ICS) (FEMA) provides a clear structure for developing and aligning communications. However, two factors might undermine ICS effectiveness during recovery operation:

- ICS effectiveness requires integration of key stakeholders, a potential challenge, as many stakeholders have yet to be identified

[3] Tokyo Subway, HKS

- The application of the ICS structure to wide-area CWA-incident recovery remains to be assessed

Advance planning can also aid in developing common information-sharing systems and methods that will allow rapid adaptation of messaging strategies as public perception and/or actions change. Without these tools, messaging is likely to be delayed and inconsistent, resulting in increased levels of pubic confusion and degradation of public trust.

Such consequences were brought to light for the U.S. during the Fukushima Daiichi nuclear power plant meltdown. In this incident, the U.S. government's lack of adequate situational awareness, which led to its inability to provide information about the potential spread of contamination to the continental United States, led to increased levels of speculation and misinformation, resulting in uncertainty across the public (Carafano, 2011).

Resources

The following websites provide additional information:

The U.S. Department of Health & Human Services provides the Public Health Emergency Response: A Guide for Leaders and Responders (U.S. Department of Health & Human Services, 2007), with an appendix that provides basic information on CWAs; the appendix is accessible via their website at: http://www.phe.gov/emergency/communication/guides/leaders/Documents/freo_appendixc.pdf.

The Centers for Disease Control and Prevention provides guidance for Communicating in the First Hours: Initial Communication With the Public During a Potential Terrorism Event (U.S. Centers for Disease Control and Prevention, 2007) at http://www.bt.cdc.gov/firsthours/.

The Centers for Disease Control and Prevention provides guidance for Chemical Emergencies (U.S. Centers for Disease Control and Prevention) at http://emergency.cdc.gov/chemical/.

4.2 Key Planning Factors: Waste Management

Key Planning Factor: Develop a pre-incident, wide-area CBR waste management plan

Pre-established plan can be tailored to specific incidents.

Description

Experience has shown that in major incidents and national exercises that most of the elements of the plan will be the same and that the most time intensive elements (i.e. Identification of Regulatory Requirements, Waste Characterization and Identification of Waste Management

Facilities and Assets) can best be planned out among appropriate parties prior to the incident. Several examples, lessons learned and resources for preparing Pre-Event CBR Waste Management Plans were presented during a DHS/EPA sponsored WARRP Waste Management Workshop that was held for the Denver UASI, from March 15-16, 2012. This workshop included Federal, State and local Waste Management and Emergency Management Officials and the materials are posted on the WARRP website.

The elements of a pre-incident waste management plan should include: identification of Federal, state, local and tribal waste management requirements; identify types and quantities of wastes anticipated; development of sampling and analysis plans of waste streams; development of waste management strategies; identification and evaluation of waste management facilities/assets and resources needed; identification of waste transportation requirements; development of waste management services contracts or mutual aid agreements; development of a waste/material tracking and reporting system; identification of waste management oversight activities; and development of a waste management community outreach and communications plan.

Significance

Recovery operations following a large-scale release of a highly toxic chemical warfare agent will likely generate very large quantities of hazardous and non-hazardous waste. Landfills and disposal sites used by most urban areas and their waste transportations systems are not typically setup to handle this type and quantity of waste. The lack of capability could significantly increase the recovery timeline.

Understanding how a state regulates a specific CBR agent can have important impacts and consequences to the recovery of a wide area incident. For example, during the WARRP Waste Management Workshop held for the Denver UASI, Colorado state waste management officials indicated that the chemical scenario involving the release of a blister agent (mustard lewisite) would result in a waste that the State of Colorado would regulate as hazardous waste. This may become a critical planning factor if a state has no appropriate waste management facility to handle the disposal of this waste which may impact the remediation strategy, timelines and cost. This may require a regional solution for the waste generated containing this specific agent.

Predetermining disposal options for managing, transporting, and disposing of large volumes of contaminated materials is therefore essential to effective response. The process may require significant time and detailed discussions with the facilities. Solutions may include establishing staging sites, treatment options, exceptions to regulatory requirements, transportation options, and disposal options.

In addition, waste management plans should consider solutions to potentially limited laboratory capacity and the development of concise risk communications to the public (on such topics as the danger of illicit dumping, for example).

Another factor that may need to be addressed associated with waste

management is the continuation of normal household or commercial waste collection and disposal services for those parts of the impacted area that were not impacted by the CBR release. This will be difficult, when the waste management resources will be devoted to the management of wastes generated from the CBR incident. These types of issues should be addressed and planned for ahead of time.

Resources

The DHS document, DRAFT *Remediation Guidance for Major Airports After a Chemical Attack* (DHS 2011) (FOUO), provides a description of waste management considerations. (Note that document is not final and has not been appropriately peer-reviewed and cleared by involved agencies.) These include a review of current regulatory guidelines for waste, a description of expected degradation products and waste streams based on current decontamination technologies and federal requirements, and an appendix on Waste Management Regulations Applicable to Chemical Weapons Agent and Toxic Industrial Chemical Decontamination. Some highlights are summarized in the next paragraphs.

The Department of Homeland Security's *National Response Framework* (http://www.fema.gov/emergency/nrf/) directs the Environmental Protection Agency (EPA) to respond to releases of hazardous materials, including chemical warfare agents and toxic industrial chemicals, in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; ESF #10–Oil and Hazardous Materials Response Annex, http://www.epa.gov/oem/content/lawsregs/ncpover.htm). The NCP provides affected areas a streamlined process to quickly address an incident; relief from administratively burdensome processes, such as permits for onsite treatment of hazardous wastes removed from a contaminated facility; and relief from regulatory provisions determined to be impracticable during an urgent response to a chemical warfare agent attack. (See 40 CFR 300.415(I); 55 *Federal Register* 8666, 8695, March 8, 1990; and http://www.epa.gov/superfund/action/guidance/remedy/overview/removal.htm.) The NCP also provides waivers to regulatory provisions under specific circumstances.

Regulation of wastes resulting from a chemical warfare agent or toxic industrial chemical attack will primarily be directed by the Resource Conservation and Recovery Act (RCRA) for solid wastes and hazardous wastes, by the Clean Water Act if wastewater is discharged to a Publicly Owned Treatment Works (POTW) or surface water body, or by equivalent state laws. Most states are authorized by the EPA to implement the RCRA hazardous waste program in lieu of EPA implementation. Under RCRA, states so authorized can be more—but not less—stringent than the EPA; thus, for any remediation activity, state regulations and state agencies should be consulted. Most states follow the format of Federal RCRA regulations. States such as California are more stringent for wastes that are considered hazardous.

If wastewater or recovered decontamination fluids are discharged to a POTW, the waste stream must meet pretreatment requirements of a local POTW and any other acceptance

criteria in the POTW permit. Discharges directly to a surface water body must meet requirements of the National Pollutant Discharge Elimination Program (NPDES) program, which are site-specific depending, in part, on the classification and criteria of the surface water body and characteristics of wastewater. Among other issues, pretreatment requirements before disposal of some wastes vary from state to state and should be verified during the planning process. Many POTWs sell sludge residues for land application in agricultural settings. The POTW must be contacted before any sewer discharge of aqueous residues from a facility-decontamination process to ensure such discharges meet facility-specific waste acceptance criteria that may be predicated on subsequent uses for sludge

4.3 Key Planning Factors: Recovery Planning

Key Planning Factor: Establish a decision-making process to select among environmental remediation options

Advance planning can facilitate the time-consuming and complex process of recovery decision-making.

Description

This Key Planning Factor is concerned with establishing the decision-making process to select among available environmental remediation options, taking into consideration many complex and competing factors, including clearance goals, health risks, resource availability, costs, timelines, and waste generation. This process should also include discussion of reimbursement/ compensation for resources provided and contingencies if resources are damaged, destroyed, etc.

Significance

Recovery operations following a large-scale release of a highly toxic chemical warfare agent will be time-consuming and complex. Advance planning for the decision-making process can facilitate the process of remediation so that, after clearance and any necessary reconstruction and refurbishment, normal community life can resume.

Resources

The DRAFT *Remediation Guidance for Major Airports After a Chemical Attack* document (DHS 2011) (FOUO) contains relevant discussions on multiple topics: strategies for containment and isolation (with particular focus on strategies for use within a facility), the evaluation of decontamination capabilities, and the development of a decontamination strategy (including source reduction, selection of decontamination technologies, and evaluation of potential environmental impacts). The Guidance also discusses decontamination technologies, including surface decontamination reagents, gas and vapor technologies, and decontamination of sensitive electronic equipment and high-value items, and provides an annex with details on specific decontamination reagents, techniques, and applications. (Note that document is not final and has not been

appropriately peer-reviewed and cleared by involved agencies.)

The DHS Bio-Response Operational Test and Evaluation (BOTE) decontamination study demonstrated that the decontamination methods selected can have significant waste management implications and costs associated with them. The key planning factor is to ensure that decontamination decisions are made from the best available data so that the decontamination and waste management processes can be optimized to reduce the overall time and cost of recovery.

Key Planning Factor: Determine requirements for, and sources of, resources for recovery from a chemical warfare agent incident

Pre-identified and pre-arranged agreements with neighboring jurisdictions can facilitate this process and speed the acquisition of the resources required for recovery.

Description

This Key Planning Factor concerns advance planning that would identify requirements for, and suppliers of, resources specifically needed for recovery from a CWA incident, including sampling kits, PPE, decontaminants, decontaminant deployment equipment, and laboratory analysis capabilities.

Significance

A recovery from a chemical warfare agent incident will likely require greater quantities and types of resources than are commonly available within a region. The speed in obtaining the full measure and range of resources needed will directly impact the effectiveness of recovery.

Advance planning will help regions identify resource requirements, determine resource shortfalls, and develop a list of needs that private suppliers or other jurisdictions might fill, and then engage with the supplier and jurisdictions to ensure the ready availability of the needed resources should an incident occur. The plan should account for unsolvable resource shortfalls so they are not just “assumed away.” For example, planning could identify the need for government or market incentives to encourage further development of resource capabilities.

Resources

Guidance can be found in the following two sources:

Department of Homeland Security, DRAFT *Remediation Guidance for Major Airports After a Chemical Attack*, LLNL TR-408173, (DHS, 2011)(FOUO). Note that document is not final and has not been appropriately peer-reviewed and cleared by involved agencies.

U.S. Environmental Protection Agency’s National Response System Flowchart (U.S. Environmental Protection Agency, 2011) at http://www.epa.gov/oem/content/nrs/snapshot.htm.

Key to the rapid recovery were situational awareness, pre-planning and advance joint exercises, and large well trained hazmat team integrated across multiple agencies. Photo source: Tu, 2007

Figure 6. Tokyo Metro Fire Department hosing equipment and station platforms with decontamination solution

4.4 Key Planning Factors: Clearance

Key Planning Factor: Establish a process to develop clearance goals specific to CWA-incident remediation

Clearance goals drive the recovery costs and timelines.

Description

This Key Planning Factor concerns the establishment of a process to develop appropriate and reasonable clearance goals that will balance political/social priorities and public health protection against time and cost constraints.

Significance

The selection of clearance goals is a very complex process that requires input from technical experts and a review and understanding of data on a range of subjects, such as the CWA physical and chemical characteristics, health-based exposure guidelines, environmental conditions, composition and characteristics of the impacted areas, and other parameters. Major challenges include the absence of good dose-response data and disagreement among stakeholders regarding the adequacy of existing CWA exposure standards.

The clearance goals are arguably the most significant drivers for the overall remediation process, strongly influencing the remediation timeline and the associated costs and resource requirements. Furthermore, timely and clear

communication of exposure-based guidelines will help greatly reduce public anxiety and thereby improve post-incident recovery activities.

Resources

DRAFT Remediation Guidance for Major Airports After a Chemical Attack (DHS, 2011) (FOUO) describes the process for evaluation of clearance and exposure guidelines to establish clearance goals, and includes discussion of the important factors: a risk-based decision approach, exposure guidelines for chemicals of concern, characteristics of CWA of concern, a summary and definitions of existing health standards and guidelines, and a discussion of the significance of the release scenario and exposure analysis to the clearance decision. (Note that document is not final and has not been appropriately peer-reviewed and cleared by involved agencies.) Some highlights are summarized below.

If a CWA terrorist incident should occur tomorrow, it is important to have ready a set of well-understood, defensible, health-protective exposure levels that can be assessed to develop appropriate and reasonable clearance goals for site-specific incidents. Accordingly, current CWA exposure guidelines have been summarized as pre-planning guidance. In the event of an actual incident, clearance goals established for pre-planning purposes must be considered with incident- and site-specific parameters and then adjusted as necessary to establish formal clearance goals.

Scientifically appropriate, well-characterized exposure guidelines must be used to ensure that human health is safeguarded without defaulting to overly conservative actions (such as cleaning to undetectable levels) that would divert limited resources without major benefits. For an actual contamination incident, site- and incident-specific factors must always be considered, and a risk-based decision process involving key stakeholders must be used.

By providing the rationale for a reasonable and scientifically supported set of procedures and health-based criteria, the Guidance document aims to give decision-makers maximum flexibility for weighing the numerous considerations (such as the safety of decontamination personnel, public health, time, funds, resources, and public perception, among others) that must be evaluated. Final decisions are made by responsible site-specific authorities, and they would reflect multiple operational factors, as well as subjective considerations of acceptable risk and socioeconomic concerns.

4.5 Key Planning Factors: Recovery Planning for CBR and All-Hazards

Key Planning Factor: Identify and create stakeholder working groups

Pre-identifying participants by position and/or skill set/expertise streamlines and adds transparency to the process, and aids in gaining buy-in from the public.

Description

A stakeholder working group can ensure a coordinated and comprehensive planning process, and develop relationships that increase post-disaster collaboration and unified decision-making. Stakeholders collaborate to maximize the use of available resources to rebuild housing, infrastructure, schools, businesses and the social fabric of the impacted community, as well as to provide health care, access and functional support services. All community perspectives are represented in all phases of disaster and recovery planning; transparency and accountability in the process are clearly evident.

Significance

Establishing processes and protocols for coordinated post-disaster recovery before an incident can greatly enhance the speed and success of recovery. Plans thus prepared can generally be implemented quickly, and because they incorporate local opinions, the plans meet community needs in a more holistic manner. Such plans also maximize the provision and utilization of recovery resources and build upon, or are incorporated into, the community master plan. In addition, community leaders can increase public confidence in the recovery process by following plan guidelines for measuring and communicating about progress, promoting transparency, accountability, and efficiency.

Furthermore, the stakeholder working groups should understand and have access to broad and diverse funding sources to finance recovery efforts and should provide knowledge and professional administration of external programs, which will greatly aid the recovery progress.

References: The Department of Homeland Security's *National Disaster Recovery Framework* (http://www.fema.gov/recoveryframework/) describes proactive community engagement, public participation, and public awareness for all hazards recovery, in addition to financial acquisition.

5 Comparisons to Other Scenarios

This document focuses on factors for recovery from a CWA incident and uses an example scenario based on a release of a specific chemical warfare agent. This section of the document highlights important differences between recovery from large-scale CWA incidents and recovery from other large-scale incidents. These differences may occur in three categories:

- Differences between recovery from CBR incidents versus natural hazards incidents
- Differences between recovery from the example CWA scenario and scenarios that involve the release of another chemical warfare agent and/or another deposition method

5.1 Differences between Recovery from CBR Incidents versus Natural Hazards Incidents

Response and recovery from CWA, biological, and radiological incidents may differ from natural hazards incidents in several important ways. Responders are more familiar with natural hazards incidents than with the rare CBR incident. Further, compared to many large-scale incidents (such as earthquakes and floods), physical damage may be minimal. Moreover, the hazard may be more insidious or unseen, cross-contamination may be an issue, exposure standards may be uncertain, and the contaminated area may require specialized decontamination. As a result of these factors, public anxiety may be heightened in a CBR incident. Therefore, building and maintaining public confidence in governmental decisions and direction is a major consideration, enhancing the importance of honest, accurate, timely, and frequent communication to the public.

Additional challenges posed by CBR incidents must also be factored into the mission of recovery. For example, maintaining and ensuring the health and safety of the responders and the general public while expediting remediation requires balancing risk-based remediation processes with concerns for economic recovery and revitalization. Restarting and recruiting businesses back into the impacted region so life transitions to a "new normal" requires levels of trust, transparency, and stakeholder involvement well beyond those needed in traditional disaster incidents. Meeting these requirements may be especially challenging due to lack of familiarity and the many resources required for recovery (such as decontamination resources and laboratory analysis capacity) may be lacking, which may delay the government's ability to implement recovery actions. The greatest potential for achieving recovery goals lies in pre-incident planning.

5.2 Differences between the Example Scenario and Other CWA Scenarios

The particular threat incident scenario used as an example in this document is only one of many possible scenarios. An important difference among CWAs is their wide range of physical and chemical properties, such as volatility, viscosity, and reactivity (see Table 5 for examples of properties).

These properties significantly impact the recovery process because they determine both the penetration of the agent into building materials (some agents penetrate some materials more deeply than others) and the persistence of the agent in the environment (some agents persist in the environment for much longer time periods than others). In addition, the reactive mechanisms to decontaminate different agents differ from one another. These differences translate into vastly different methods for remediation, which in turn may result in large differences in the time required for recovery. Nonetheless, the Key Planning Factors described in this document apply to recovery from all types of CWA incidents.

Table 5: Example chemical/physical properties of chemical warfare agents

Chemical/Physical Property	Mustard (HD)	Lewisite (L)	Sarin (GB)	VX
Boiling-point °C	217	190	151	298
Melting-point °C	14.6	-18	-56	-39
Vapor pressure mm Hg at 20°C	0.072	0.35	2.1	0.00044
Volatility mg/m³ at 20°C	610	4480	16,091	5.85

(Source: http://cbwinfo.com [for HD, GB], Franke, S., *Manual of Military Chemistry, Volume 1. Chemistry of Chemical Warfare Agents*, Deutscher Militîrverlag: Berlin (East), 1967. Translated from German by U.S. Department of Commerce, National Bureau of Standards, Institute for Applied Technology, NTIS no. AD-849 866, pp. 247, 252[for L])

6 Planning Recommendations

Initiating efforts to address these Key Planning Factors may be daunting for communities new to CBR concepts and planning. To make immediate planning progress with (always) limited funds, a community could consider approaching each KPF as a series of graduated sub-tasks or planning phases. Examples of steps in such an approach for each KPF follow.

- **Establish protocols for first responders to rapidly identify the CWA and determine its volatility and persistence:** Train responders on established HazMAT guidance for CWAs. Upgrade sampling equipment.
- **Establish protocols for control of agent fate and transport after initial incident:** Start with existing protocols for establishing and controlling restricted areas. Establish protocols for rapidly establishing controls for hospital entry. Develop decontamination process for entry and exit of restricted areas.
- **Develop protocols to determine extent of contamination:** Begin with established procedures and equipment already in jurisdiction. Acquire additional and more sophisticated sampling equipment. Develop protocols to rapidly gain access to additional workers and equipment in an incident.
- **Develop CWA-specific public messaging and communication strategies prior to an incident:** Begin with existing communication plans for all hazards. Consult with subject-matter experts to develop CWA-specific message templates and protocols. Develop agreements and protocols for obtaining real-time SME expertise in an on-going incident.
- **Develop a pre-incident, wide-area CBR waste management plan:** Begin with existing plans for disposal of hazardous waste; extend processes to cover waste contaminated by chemical warfare agents and their decontamination break-down products. Identify waste disposal sites beyond the region to begin to build excess capacity.
- **Establish a decision-making process to select among environmental remediation options:** Train Stakeholder Working Group and decision-makers on remediation options. Develop playbook for consultation during an incident. Develop a process for decision-making.
- **Determine requirements for, and sources of, resources for recovery from a CWA incident:** Based on potential CWA scenario and appropriate remediation options, develop a list of required resources. Identify sources of personnel and equipment. Develop agreements and protocols to obtain necessary resources in an incident.
- **KPF Establish a process to develop clearance goals specific to CWA-incident remediation:** Train Stakeholder Working Group and decision-makers on national advice. Develop protocols to consult subject matter experts real time in an

incident. Develop a process for decision-making.

- **Identify/Create Stakeholder Working Group:** The more agencies and stakeholders in a region, the more important it will be to identify working group participants and community champions, and the more involved developing a decision-making process will be. The pre-incident planning effort could be phased: 1) Identify stakeholders, 2) Socialize chemical incident scenarios and key planning needs, 3) Identify additional stakeholders, etc.

7 Conclusions

A chemical warfare agent incident has the potential to disrupt life and business in a community through the potential for human casualties and land and facility contamination. Confusion and delay in response and communication can exacerbate the problem and erode public confidence. Conversely, advance planning, with particular emphasis on the Key Planning Factors identified in this document, could substantially aid the recovery process by decreasing the recovery timeline and costs, improving public health and safety, and addressing major resource limitations and critical decisions.

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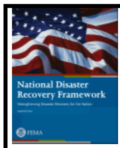
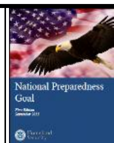
Appendix 1: Comparison between Recovery Support Functions, Core Capabilities, and Key Planning Factors

The following table shows the relationship among the National Disaster Recovery Framework (NDRF) (Federal Emergency Management Association, 2011) Recovery Support Functions, the National Preparedness Goal (FEMA, 2011) Recovery Core Capabilities, and the WARRP Key Planning Factors.

 **NDRF Recovery Support Functions**	 **NPG Recovery Core Capabilities**	**Wide Area Recovery & Resiliency Program *Chemical* Key Planning Factors**
Community Planning and Capacity Building	Planning	Establish protocols for control of agent fate and transport after initial incident
		Develop a pre-incident, wide-area CBR Waste Management Plan
	Operational coordination	Identify and create Stakeholder Working Group
		Establish protocols for first responders to rapidly identify the CWA and determine its volatility and persistence
		Establish decision-making process to select among environmental remediation options
		Determine requirements for, and sources of, the resources for recovery from a CWA incident
	Public Information & Warning	Develop CWA-specific public messaging and communication strategies prior to an incident
Economic	Economic	
Health and Social Services	Health and Social Services	Develop protocols to determine extent of contamination
		Establish process to develop clearance goals specific to CWA-incident remediation
		Establish process to develop clearance goals specific to CWA-incident remediation

Housing	Housing	
Infrastructure Systems	Infrastructure Systems	
Natural and Cultural Resources	Natural and Cultural Resources	

Appendix 2: Wide-Area Response and Recovery Phases

A common misconception is that recovery begins after the response phase. Recovery, however, actually begins during response with many initial recovery activities taking place in parallel with similar response activities. Recovery planning and recovery of certain critical facilities are both so important that they will begin early. Also, response actions taken will have a large impact on future recovery, thus both must be considered together. Key Federal documents that describe this include:

- The National Disaster Recovery Framework, (Federal Emergency Management Agency, September 2011)
- Draft Planning Guidance for Recovery Following Biological Incidents (DHS-EPA, 2009)

These documents describe similar phases; however, the focus and terminology are slightly different. As presented in the 2011 National Disaster Recovery Framework (NDRF), an incident can be divided into short-, intermediate, and long-term phases. The Draft Planning Guidance for Recovery Following Biological Incidents (DHS-EPA, 2009) divides the incident into Notification, First Response, Characterization, Decontamination, Clearance and Restoration/Reoccupancy. This guidance also has been applied to Chemical Incidents (LLNL, 2012), and has many similarities to Radiological Response and Recovery tasks.

The two approaches to the problem do not match exactly, as one is time based (Figure A2-1 from the NDRF) and the other is task base (Figure A2-2 from DHS/EPA, 2009). This comparison of the phases is useful to allow coordination between different entities with different responsibilities.

The following paragraphs describe the task-based phases as functions within a time-phase framework. It is understood that this is not a perfect correlation, but may be a useful comparison.

A2-1 Short-Term Recovery Phase

The short-term phase initiates Response, which begins with the identification of an incident, continues with notification and emergency first-response phases, and continues for as long as emergency personnel are present. It also includes initial recovery actions as described in the NDRF. "The short-term recovery phase addresses the health and safety needs beyond rescue, the assessment of the scope of damages and needs, the restoration of basic infrastructure and the mobilization of recovery organizations and resources including restarting and/or restoring essential services for recovery decision making." (FEMA, 2011). Early response actions following receipt of information on the CWA include, but are not limited to, the identification of suspected release sites and notification of appropriate agencies. Actions in this period are likely to be conducted with minimal or incomplete information on the nature and extent of the incident.

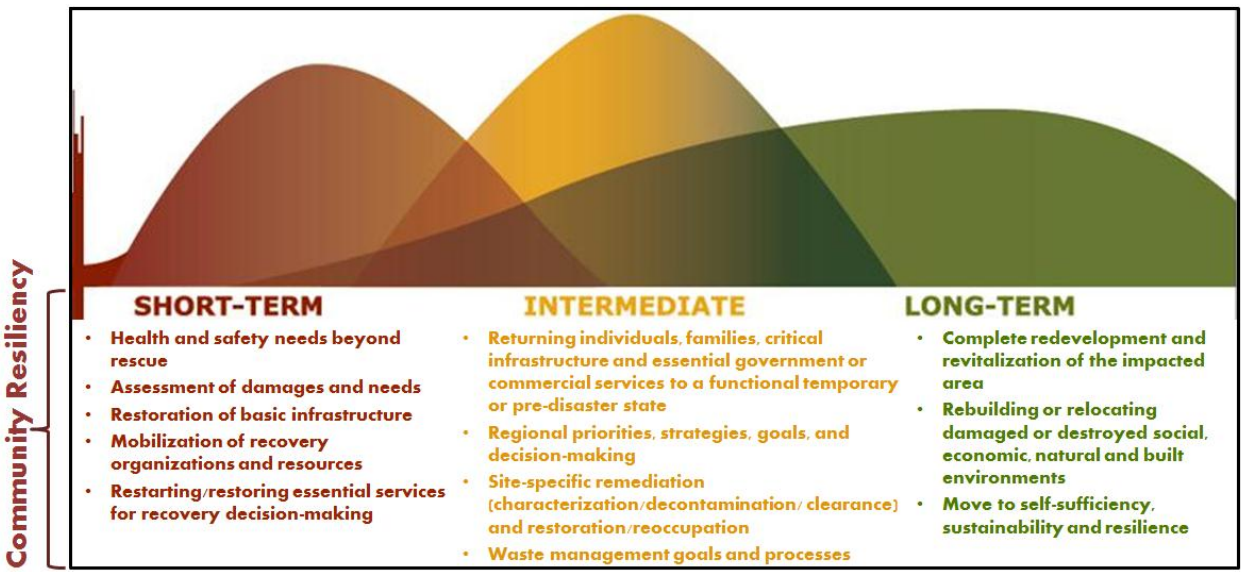


Figure A2-1. National Recovery Framework Phases

Response and Recovery *					
Notification	First Response	Remediation/Cleanup			Restoration/ Reoccupation
		Characterization	Decontamination	Clearance	
Receive information on chemical incident	Initial threat assessment	Characterization of chemical agent	Decontamination strategy	Clearance environmental sampling and analysis	Renovation
Identification of suspect release sites	HazMat and emergency actions	Characterization of affected site(s)	Remediation Action Plans	Clearance decision	Reoccupation decision
Notification of appropriate agencies	Forensic investigation	Site containment	Worker health and safety		Long-term environmental and public health monitoring
	Public health actions	Continue risk communication	Site preparation Source reduction		
	Screening sampling	Characterization environmentla sampling and	Waste disposal		
	Determination of agent type, concentration, and viability	Initial risk assessment	Decontamination of sites and items		
	Risk communication	Clearance goals	Decontamination verification		
*The optimization decision process is applicable to any phase					

Figure A2-2. Chemical Agent Response and Recovery Activities

A2-2 Intermediate-Term Recovery Phase

The intermediate-term engages technical experts and stakeholders to perform on-going assessment and evaluation of risks and to prioritize and make decisions for the wide-area context under the Incident/Unified Command (IC/UC) of the National Incident Management Structure (NIMS). The intermediate term also begins site-specific remediation and restoration, which includes characterization, decontamination, and clearance, as well as restoration/ reoccupation of individual indoor or outdoor sites. For simplicity, clearance and restoration/ reoccupation are discussed under the long-term phase.

Important Functions within the Intermediate Phase

Risk Assessment: This step focuses on performing screening environmental sampling to determine the extent and levels of contamination; assessing environmental characteristics of the CWA that affect its subsequent spread, such as its persistence on surfaces and potential for further spread, e.g. through tracking, vaporization, reaerosolization; and characterizing and communicating the impacts and risks in terms of the potential health consequences to humans and harm to the environment. An environmental risk assessment for remediation purposes is conducted. Collected information is evaluated to identify and evaluate risk-reduction options for indoors and outdoors. On-going risk assessment may include long-term environmental and public health monitoring.

Prioritization: During this activity, engaging stakeholders is crucial in order to develop regional recovery priorities and to prioritize the areas and facilities. Because of critical access issues and the likelihood of recontamination, certain outdoor areas may be given priority.

Characterization Phase: The focus in this phase is on planning and performing characterization environmental sampling to determine the extent of contamination at each particular site. Characterization may define broad bands for the hot/high concentration zone, cold (meets cleanup/acceptable) concentration zone, and the middle zone. Collected information is evaluated to determine what types of decontamination are needed for this site.

Decontamination Phase: The decontamination phase, which begins in the intermediate phase and may continue into the long-term phase, focuses on preparing and implementing detailed plans for decontaminating those contaminated items, areas, and facilities deemed suitable for such treatment. During this phase scenario- and site-specific decontamination reagents and delivery systems will be selected, and all systems will be evaluated and tested if necessary before carrying out chemical treatments. Weathering/monitored natural attenuation may also be an adequate decontamination option. In cases where contamination is not extensive or the agent is not environmentally persistent, application of surface decontaminants or other methods of medical infection control may be effective. For extensive contamination especially in indoor areas,

fumigation is an option. In those cases, source reduction is considered, which involves removing salvageable and non-salvageable items, and pre-cleaning surfaces to reduce contaminant load.

A2-3 Long-Term Recovery Phase

In the case of a wide-area contamination involving potentially hundreds to thousands of buildings and outdoor sites, the remediation and restoration phases may stretch into the long term, particularly since the decontamination and clearance phases will likely require the use of scarce decontamination and laboratory resources. Waste management is also a major activity that bridges the intermediate- and longer-term recovery phases.

Important Functions within the Intermediate Phase

Clearance Phase: This phase, which begins in the intermediate phase, focuses on determining whether clearance goals have been met. Appropriate experts (generally the Technical Working Group and the Environmental Clearance Committee) review and evaluate key data, such as characterization and clearance environmental sampling results, decontamination process parameters and verification results, quality assurance and quality control (QA/QC) data, and other relevant information. Clearance criteria are applied to judge the effectiveness of any decontamination processes that may have been used. Final decisions on clearance are made by local, state, or Federal public health officials, or government agencies, depending on site-specific jurisdictional authorities.

Restoration & Reoccupation Phase: The focus for this phase is on preparing an area or facility for re-occupancy, reuse, or refurbishment, such as renovating indoor areas that have undergone fumigation. Restoration can include upgrading equipment in critical infrastructure to mitigate the effect of possible future attacks.

Appendix 3: Chemical Agent Toxicity

The more toxic a chemical, the smaller the amount of chemical required to cause harm. This table compares the lethal concentrations in parts per million (ppm) for acute (all-at-once) exposures to some chemical weapons and some common industrial chemicals.

Chemical Agent	**Approx. Lethal Concentration* (in ppm)**
Some chemical warfare agents	
Sarin (GB)	36
Hydrogen Cyanide**	120
Some toxic industrial chemicals	
Chlorine**	293
Hydrogen chloride	3,000
Carbon monoxide	4,000
Ammonia	16,000
Chloroform	20,000
Vinyl chloride	100,000
*Based on LC_{50} values in laboratory rats: exposure concentration for 60 minutes at which 50% of rats would die. Rats are used for toxicology tests in part because of similarity to humans, but they are likely to be more susceptible because they have higher metabolisms.	
**Used both as chemical weapons and as industrial chemicals	
Source: NRC, EPA, and ATSDR	